SYNOPSIS

TERRAIN EVALUATION- A CASE STUDY OF BIRBHUM DISTRICT, WEST BENGAL

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INTRODUCTION: The topography, also referred to as land relief, is the ground surface's vertical and horizontal dimensions. Geomorphic resources are the natural occurrences that occur on Earth's surface as a result of continuous geomorphic processes.(Singh, 2015).Because landforms offer chances for industrial and agricultural growth as well as shelter to those in need, studying landforms is crucial to the study of geomorphology.(Kumar et al., 2017).Applied Geomorphology sub-branch assesses terrain for land use planning, determining agricultural preferences and recreational/residential preferences, highlighting the suitability of properties in different terrain types.(Prasad & Sarkar, 2011).In order to fully grasp the engineering characteristics of a given location, soil samples and other information sources are used in terrain studies, which are essential for highway research and design. The study of the features that comprise the earth's surface and how they relate to the underlying geology is known as geomorphology. (Adebola et al., 2017). Present highway alignment planning and construction techniques rely on 2D topographic maps, the planners' "imagination," and their experience deciphering photographs and other data. (Makanae & Dawood, 2005). Although numerous historical studies have documented the effects of geology on trench building, water supply, tunneling, and aggregate availability, the topography itself has been taken into consideration when determining the result of conflicts in the Flanders region.(Doyle & Bennett, 1997) .The assessment of landform changes in the two sub-watersheds, which show variations in the denudational history of adjacent watersheds, is made possible using terrain analysis. (Prasannakumar et al., 2013). (Lavkulich, 1979). Gully erosion, a major environmental issue, affects 15% of the global area, 39.0% of Asia, and 9.4% of India's total land area. (Jha & Kapat, 2009).

These soils are generally weak in humus, moderately to highly worn, rich in secondary forms of iron (Fe) or aluminum (Al) or both, and, depending on their topographic location, may have a clay-enriched B horizon. **(G. K. Ghosh, 2019)**. Land degradation research must include studies of soil erosion at local scales, such as the individual gully system. Global research has also extensively examined gully head shape as the primary driver of gully growth. **(Shit & Maiti, 2013)**. Gully erosion is a particularly harmful phenomenon that lacks adequate definition and measurement at this time. Studies have been conducted on the gully head topographic threshold in relation to Hortonian runoff in agriculture, rangeland, and forests. **(Rossi et al., 2022).** The lateritic Santinikean-Sriniketan area, on the northern slope of the Ajay-Kopai interfluves of Birbhum district, was one of the best known badland (Khoyai) localities of West Bengal**. (Das & Bandyopadhyay, 2023).** Badlands, formed by active rills and water erosion, are found in Purulia, Bankura, Birbhum, and West Medinipur districts of West Bengal, including 'Khoyai'. **(Bhoumick, 2019)**. Erosion by rivers is a hydro-geomorphic process that involves the dissolution of rock, soil, and debris from the earth's surface. It includes gully, rill, and overland flow erosion. **(S. Ghosh & Bhattacharya, 2012)**. Drainage basin is an area drained by the stream and its

tributaries. It is bounded by the drainage divide. Drainage basin is also sometimes called watershed or catchment area**. (Karim, 2020)**. Hydrologic phenomena such as drainage basin size, shape, slope, density, stream length, order, and pattern are influenced by morphometric analysis, which quantifies the dimensions and surface structure of the Earth.**(Veeranna et al., 2017)**. One of the best resources for comprehending the hydrological and geomorphological features of a river basin is a morphometric analysis of the drainage system. **(Tewari et al., 2019).** Morphometric analysis calculates a watershed's general characteristics, such as stream length, bifurcation ratio, and drainage density, by calculating its linear, areal, and relief aspects.**(Asfaw & Workineh, 2019)**. The morphometric analysis of channel networks and drainage basins is essential to comprehending the behavior of geo-hydrology and to express geology, geomorphology, climate, and structural control. **(Sarma et al., 2013)**. The most dominant geomorphic systems of earth's surface arerivers and fluvial processes which leads to morphometric changes in drainage basin or the watershed. **(Kulkarni, 2013)**. To describe the valley side and channel slopes, relief, area, kind and extent of the drainage network, and other features concerning drainage basins, a multitude of quantitative metrics have been developed.**(Ghatol & Parimal, 2022).** Natural hazards are global events that can reshape the landscape of the Earth and influence the human environment significantly. **(Bashir, 2023).**

STATE OF THE ART: One major environmental problem is gully erosion, which is the removal of soil along drainage lines by surface water runoff. To comprehend and lessen its consequences, recent research has combined field observations, modeling methodologies, remote sensing technology, and sustainable management practices. Advanced monitoring tools are used in field investigations, large-scale spatial data is obtained by remote sensing, and detection and extraction procedures are automated by machine learning algorithms. While engineering, vegetative, and land use techniques in sustainable management strategies limit and mitigate erosion, modeling methodologies simulate erosion processes at various scales. The necessity of integrated approaches is emphasized by the state of the art in gully erosion research.

PROBLEM TO BE INVESTIGATED: Little sculptures and patterns are produced by the geomorphic agents in the sediment layers and on the landmass' surface
A more appropriate definition of micro geomorphology would be that it is a branch of landform science that focuses on minute geomorphic features and their importance throughout time and space. In Birbhum district, India, gully erosion is a serious environmental problem that is typified by channels becoming wider and deeper as a result of concentrated water flow. Understanding geological and geomorphological elements, changes in land use and cover, hydrological dynamics, soil characteristics and erosion vulnerability, socioeconomic effects, remote sensing and GIS tools, and policy and institutional frameworks are some of the major research challenges. It is essential to comprehend these elements in order to create resilient land management strategies and initiatives. Erosion rates can be made worse by changes in land use, such as urbanization, deforestation, and increased agriculture. To create solutions that work, it's also critical to comprehend the socioeconomic effects, soil characteristics, and hydrological dynamics. Finally, efficient erosion management requires a multidisciplinary strategy that incorporates perspectives from the geological, hydrological, socio-economic, and technological domains. One way to characterize these these marks is as micro geomorphic features. Due to

both natural and man-made sources, gully erosion poses a serious danger to land degradation in areas like Birbhum, India. It weakens the fertility of the soil, lowers agricultural output, and endangers infrastructure. Technological interventions, hydrological studies, geomorphological study, and community involvement are examples of mitigation measures. Resilience can be increased by placing a high priority on socioeconomic development and environmental preservation.

OBJECTIVES:

1. To identify major and minor geomorphic features of study area.
2. To identifies soil types, drainage patterns, and landform variations,
3. To analysis the characteristics of the landforms of the study area.
4. To analyse the character of the terrain and the spatial distribution of lateritic Upland in relation to landscape setting.
5. To terrain evaluation in Birbhum District assesses land suitability for agriculture, infrastructure development, and environmental conservation.
6. To study the socio-cultural and economic conditions of the local inhabitant in relation with this geomorphic landscape
7. To aiming to optimize land use planning and support sustainable development
8. To ecological conservation and disaster risk reduction.

HYPOTHESIS:

1. Terrain Characteristics Influence Land Use Patterns: The hypothesis suggests that land use patterns in Birbhum district are significantly influenced by variations in terrain characteristics like elevation, slope, aspect, and soil type.

2. Topographic Features Impact Agricultural Productivity: The hypothesis suggests that topographic features, such as slope and aspect, directly influence agricultural productivity in Birbhum district, with certain areas being more suitable for specific crops.

3. Terrain Attributes Affect Water Resource Distribution: The hypothesis suggests that terrain attributes like elevation and slope affect water resource distribution and availability, impacting agricultural practices and land use in Birbhum district.

4. Terrain-based Risk Assessment for Natural Hazards: The hypothesis suggests that terrain evaluation can help determine the vulnerability of different Birbhum district areas to natural hazards like floods, landslides, and erosion.

STUDY AREA: Birbhum (latitude ranges of 23°32’30” to 24°35’00"N and longitude ranges of 87°5’25" E to 88°1’40" E.), the northernmost district of the Burdwan division, spans 4545 km² and is surrounded by Murshidabad, Burdwan, and Santal Parganas regions. Administratively

divided into three subdivisions, 27 villages, and nineteen community development blocks, it features a divided plateau with Archean crystalline rocks and Gondwana deposits. The study region includes the Ajay, Mayurakshi, Dwarka, Brahmini, and Bansloi river basins, part of the 'Rarh' area.

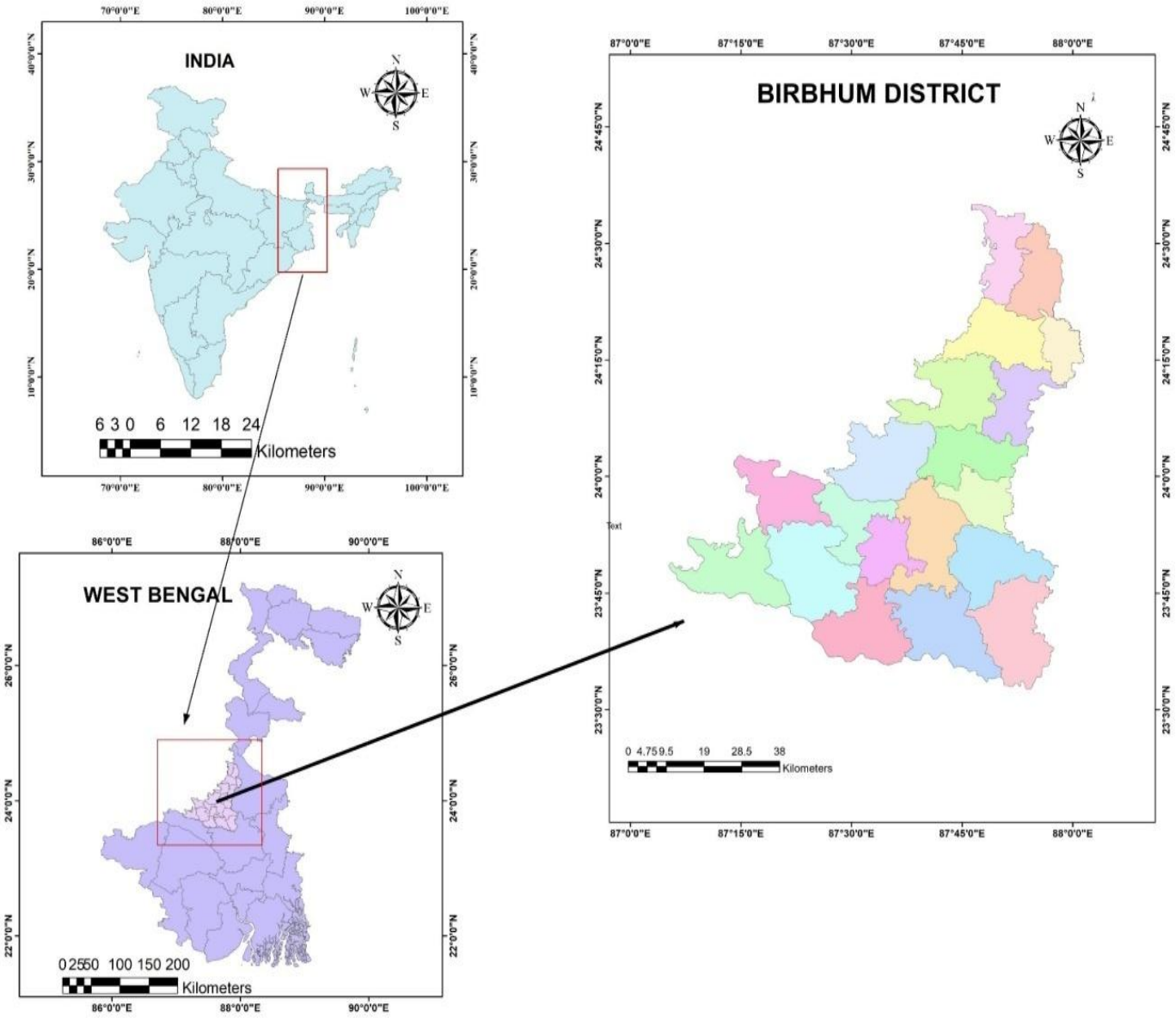

FIG: STUDY AREA

RESEARCH DESIGN AND METHODOLOGY:

The study identifies badland topography and demarcates the area using literature and secondary data from the District census Handbook in Birbhum District.

Fieldwork involves identifying lateritic patch landscapes, conducting socio-cultural and economic surveys, and preparing questionnaires to understand groundwater's influence on agricultural development.

Post-fieldwork uses statistical tools, cartographic techniques, and statistical analysis to analyze agricultural regionalization in Birbhum District. IDW and Choropleth maps are used to show groundwater potentiality and agricultural regionalization.

Fieldwork (identification of geomorphic features and field observation)—SOI Toposheet (1:50000 scale)—Digital data (high resolution IRS digital data—IRS, LIS I,II,III , Product images of PAN and LIS I,II,III data)—Data processing—Geometric correction. The entire field data were organized, coded and were put through for further analysis using MS Excel and statistical packages such as SPSS. The study uses precision geocoded P6 and LISS III data, toposheets, rainfall data, census maps, and field data to identify and delineate basins with varying lateritic exposure and rill-gully networks. It considers 45 sub catchments of tributary basins of two main river systems, Ajay. and Mauyrakshi. Morphometric analysis of linear areal and relief is done using satellite images, toposheets, and field data. Sample basins are divided into grids of $1km^2$, and rill-gully affected patches into $100m^2$.

TENTATIVE CHAPTERISATION:

Introduction

CHAPTER-1: Geographical background of the study area

CHAPTER-2:Morphometric analysis of this study area

CHAPERT-3: The topographic expression and badland- a vanishing landscape

CHAPTER-4: Terrain classification and agricultural practices

CHAPTER-5: Application of terrain evaluation

CHAPTER-6: Conclusion

Bibliography

Appendix

SOURCES OF DATA AND TOOLS TO BE USED IN COLLECTION OF DATA:

The Universal Transverse Mercator Projection's Northern Zone 45 datum WGS84 was used to enter all of the data in the data collection section. The Survey of India (SOI) 1:50,000 scale topographical maps (sheet nos. 72P Series- P/12, P/14, P/15, P/16, 73M/1, 73M/5, 73M/6, 73M/9, 73M/10, 73M/13, 73M/14, 73D/3, 73D/4) were used to generate the drainage map. The resulting map of soil texture was made available by the Birbhum District Portal. (https://www.birbhum.gov.in/) . A slope map was created using the shuttle Radar Topography Mission Digital Elevation Model (SRTM DEMV3, 1-arc sec) and the spatial analysis tool in Arc GIS. Using information from the ISRO Geo-portal Bhuvan and the LISS-III picture (Path/row: 107/55) the land use and land cover (LULC) map was produced. (http://bhuvan.nrsc.gov.in). ArcGIS was then used to digitize it. Lineament map obtained from ISRO's Bhuvan Geo-portal (http://bhuvan.nrsc.gov.in), Afterwards, using the line density approach in the spatial analysis tool in ArcGIS, a lineament density map was created. Secondary data basically agricultural data are collected from District Census Handbook, Birbhum.

DATA ANALYSIS: For statistical testing, field research data was utilized, and micro-relief variations were computed using micro-slope angles measured using a clinometer. Utilizing software, the relationship between plant coverage and slopes was examined. The undulation range is shown by the maximum microslope angle. Gully erosion is a significant environmental and socio-economic threat in the Birbhum district of West Bengal, India. Researchers have conducted a comprehensive data analysis to understand its causes, impacts, and mitigation strategies. They identified gully erosion hotspots through remote sensing data and field surveys, analyzed environmental factors like rainfall patterns and soil types, assessed socio-economic impacts like agricultural land loss and displacement, and used hydrological models to simulate water runoff and erosion processes. They evaluated mitigation measures like contour plowing, terracing, vegetative barriers, and check dams, and assessed community participation and stakeholder engagement. They also analyzed existing policies and institutional frameworks to recommend policy reforms and capacity building. The researchers also incorporated indigenous knowledge to enhance community resilience to gully erosion. This comprehensive data analysis contributes to the development of sustainable solutions that protect natural resources and human well-being. The study area in the Rahr Bengal has a significant lateritic landscape degraded by rill, gully, and stream networks. In order to analyze the network system of the gully basin, the authors have created a network model in which the primary channel is designated as the First order channel, the direct connection as the Second order channel, and the meeting channel as the Third order channel. The eastern part of the area experiences distinct rill and gully erosion exposures, mainly in the 3rd and 2nd order subbasins of the Kopai and Mauyrakshi Rivers. The remaining areas are mostly subject to rill erosion and small gullies. The propensity for erosion is high in non-arable lands like protected forests, mining waste, barren terrain, and marginal agricultural plots. The study area in Rahr Bengal is severely degraded by rill, gully, and stream networks, with the eastern part experiencing distinct erosion exposures. Non-arable lands, protected forests, mining waste, and barren terrain are highly susceptible.

SIGNIFICANCE OF THE STUDY: Because of the varied topography of the Birbhum area of India, evaluating the terrain is essential to research. Crop production and appropriateness are

impacted by changes in microclimate, drainage patterns, and soil fertility. It helps with urban planning and land use planning by pointing out good locations for infrastructure expansion while reducing environmental damage. Additionally, it supports the development of conservation strategies and the identification of environmentally vulnerable areas in environmental conservation activities. It also helps with early warning system development, hazard-prone region mapping, and disaster management. In general, terrain assessment is essential to comprehending the varied topography of the area, allowing for sustainable practices and well-informed decisions to support the resilience of populations and ecosystems.

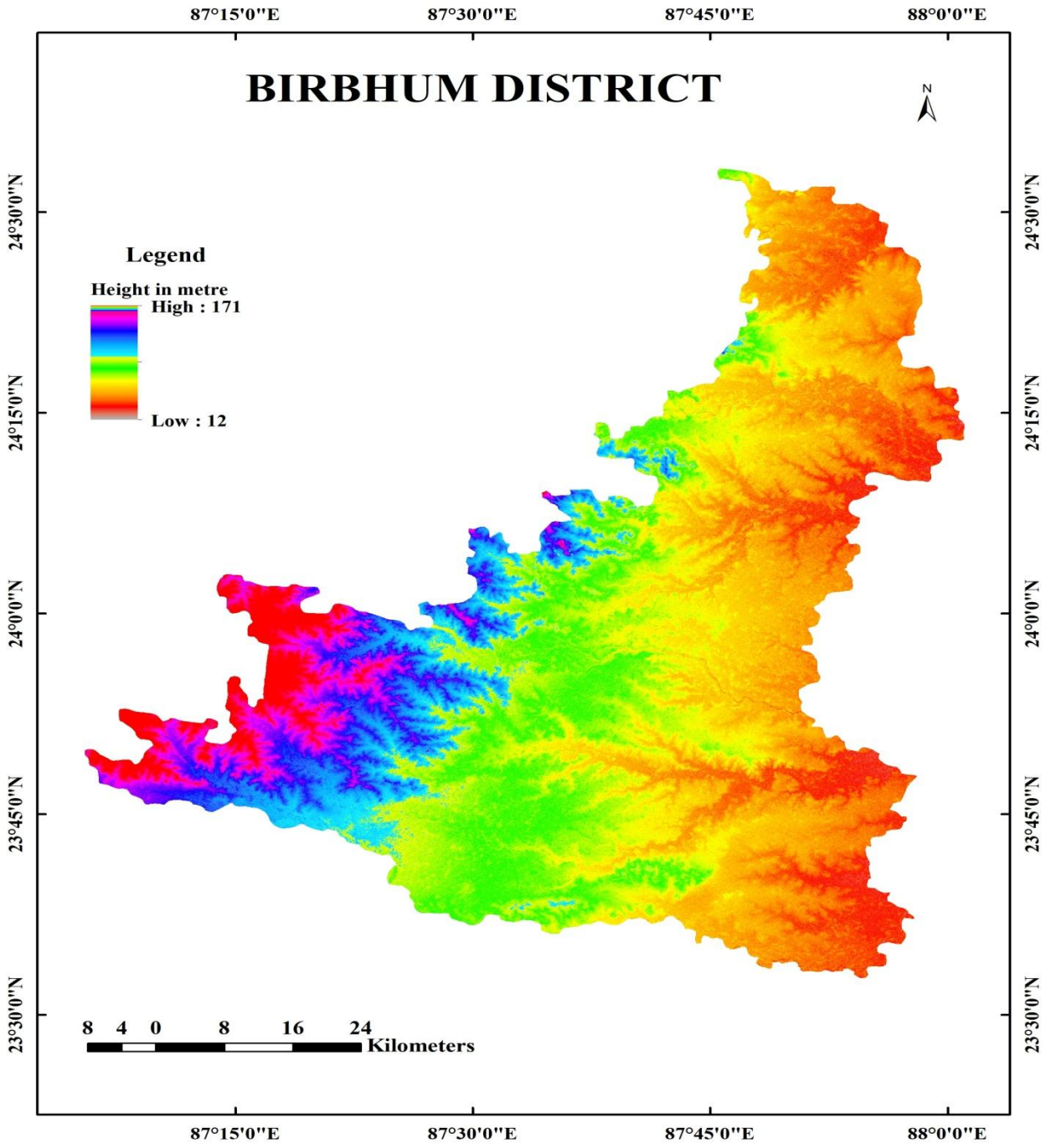

FIG: DEM OF THIS STUDY AREA

RELEVANCE OF PRESENT DAY PROBLEMS : Terrain evaluation is crucial in addressing the challenges faced by Birbhum district in West Bengal, India. The district's undulating topography and diverse land uses pose significant challenges. It is prone to natural disasters like floods and landslides, which require comprehensive terrain analysis to identify flood-prone areas and assess drainage patterns. It is also essential for sustainable land use planning and natural resource management, as the district's terrain includes agricultural lands, forests, urban areas, and

mining sites. Terrain evaluation also aids in infrastructure development and transportation planning, identifying optimal routes and minimizing construction costs. It is also vital for addressing environmental degradation and promoting ecosystem conservation, as the district's diverse terrain harbors rich biodiversity threatened by deforestation, mining activities, and improper land use practices.

EXISTING KNOWLEDGE: West Bengal, India's Birbhum District is well-known for its varied topography, which is essential for agriculture, land management, infrastructural growth, and environmental preservation. The district's topography consists of hilly terrain and fertile alluvial plains, with rainfall having an impact on land stability and soil erosion. Understanding soil kinds and qualities requires an understanding of soil mapping and classification. Slope stability, erosion processes, and landforms are all evaluated with the aid of geomorphological analysis. Terrain characteristics and land use requirements for agriculture, urbanization, and conservation are included in land suitability assessment. The landscape and ecosystem dynamics have changed as a result of human activities including mining, urbanization, and deforestation, underscoring the necessity of sustainable land management techniques. Data accessibility, restrictions on spatial scale, and the integration of old knowledge systems are among the difficulties. Incorporating local community perspectives, enhancing the spatial resolution of terrain data, and creating decision support systems for natural resource management and land use planning should be the main goals of future study.

FUTURE WORK: Terrain evaluation is crucial in agriculture, urban planning, disaster management, and environmental conservation. In Birbhum district, India, researchers can use advanced remote sensing technologies and GIS to enhance understanding of terrain characteristics. They can assess terrain stability, identify vulnerable areas, and develop predictive models for sustainable land management. The district's terrain also influences soil erosion and water runoff patterns. Urban planning and infrastructure development can be optimized by considering terrain-based suitability for urban expansion and transportation networks. Ecological conservation and biodiversity management can be prioritized by assessing terrain types and prioritizing conservation efforts. Climate change adaptation and resilience planning can be developed by integrating climate projections with terrain evaluation. In conclusion, interdisciplinary research in terrain evaluation in Birbhum district can contribute to sustainable development and resilience building.

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